STORM WATER MANAGEMENT PLAN
FOR
LOS ARBOLADOS

Permit No. TM 5406 RPL2
LOG NO.ER 04-08-042

Prepared By:
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For:
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January 17, 2008, 2005

Storm Water Management Plan
For Priority Projects
(Major SWMP)

Project Name:	LOS ARBOLADOS
Permit Number (Land Development Projects):	N/A
Work Authorization Number (CIP):	N/A
Applicant:	LOS ARBOLADOS LIMITED PARTNERSHIP, LTD
Applicant's Address:	6180 PASEO ARBOLADO RANCHO SANTA FE, CA
Plan Prepare By (*Leave blank if same as applicant*):	
Date:	10/17/05
Revision Date (If applicable):	N/A

The County of San Diego Watershed Protection, Storm Water Management, and Discharge Control Ordinance (WPO) (Ordinance No. 9424) requires all applications for a permit or approval associated with a Land Disturbance Activity must be accompanied by a Storm Water Management Plan (SWMP) (section 67.804.f). The purpose of the SWMP is to describe how the project will minimize the short and long-term impacts on receiving water quality. Projects that meet the criteria for a priority project are required to prepare a Major SWMP.

Since the SWMP is a living document, revisions may be necessary during various stages of approval by the County. Please provide the approval information requested below.

Project Review Stage	Does the SWMP need revisions?		If YES, Provide Revision Date
	YES	NO	
TENTATIVE MAP/SECOND SUBMITTAL	YES		01/12/05

Instructions for a Major SWMP can be downloaded at http://www.co.san-diego.ca.us/dpw/stormwater/susmp.html.

Completion of the following checklist and attachments will fulfill the requirements of a Major SWMP for the project listed above.

PROJECT DESCRIPTION

Please provide a brief description of the project in the following box. For example:
The 50-acre RC Ranch project is located on the south side of San Miguel Road in the County of San Diego (See Attachment 1). The project is approximately 1.0 mile east of the intersection of San Miguel Avenue and San Miguel Road and 1 mile south of the Sweetwater Reservoir. This project will consist of a planned residential community comprising of 45 single-family homes 72 and multi-unit dwellings.

The 1.95 acre (gross) project is located in Rancho Santa Fe in the County of San Diego at the end of Camino Selva in between Villa De Santa Fe and Villa De La Valle. (see Attachment A). This project will consist of construction of 6 residential units. The surrounding land use is single family residential.

PRIORITY PROJECT DETERMINATION

Please check the box that best describes the project. Does the project meet one of the following criteria?

PRIORITY PROJECT	YES	NO
Redevelopment within the County Urban Area that creates or adds at least 5,000 net square feet of additional impervious surface area	YES	
Residential development of more than 10 units		NO
Commercial developments with a land area for development of greater than 100,000 square feet		NO
Automotive repair shops		NO
Restaurants, where the land area for development is greater than 5,000 square feet		NO
Hillside development, in an area with known erosive soil conditions, where there will be grading on any natural slope that is twenty-five percent or greater, if the development creates 5,000 square feet or more of impervious surface	YES	
Environmentally Sensitive Areas: All development and redevelopment located within or directly adjacent to or discharging directly to an environmentally sensitive area (where discharges from the development or redevelopment will enter receiving waters within the environmentally sensitive area), which either creates 2,500 square feet of impervious surface on a proposed project site or increases the area of imperviousness of a proposed project site to 10% or more of its naturally occurring condition.		NO
Parking Lots 5,000 square feet or more or with 15 parking spaces or more and potentially exposed to urban runoff		NO
Streets, roads, highways, and freeways which would create a new paved surface that is 5,000 square feet or greater	YES	

Limited Exclusion: Trenching and resurfacing work associated with utility projects are not considered priority projects. Parking lots, buildings and other structures associated with utility projects are subject to SUSMP requirements if one or more of the criteria above are met.

If you answered **NO** to all the questions, then **STOP**. Please complete a Minor SWMP for your project.

If you answered YES to any of the questions, please continue.

The following questions provide a guide to collecting information relevant to project stormwater quality issues. Please provide a description of the findings in text box below.

	QUESTIONS	COMPLETED	NA
1.	Describe the topography of the project area.	GRADUAL HILL	
2.	Describe the local land use within the project area and adjacent areas.	SINGLE FAMILY RESIDENTIAL	
3.	Evaluate the presence of dry weather flow.	NONE	
4.	Determine the receiving waters that may be affected by the project throughout the project life cycle (i.e., construction, maintenance and operation).	COMPLETED	
5.	For the project limits, list the 303(d) impaired receiving water bodies and their constituents of concern.	COMPLETED	
6.	Determine if there are any High Risk Areas (municipal or domestic water supply reservoirs or groundwater percolation facilities) within the project limits.	COMPLETED	
7.	Determine the Regional Board special requirements, including TMDLs, effluent limits, etc.	COMPLETED	
8.	Determine the general climate of the project area. Identify annual rainfall and rainfall intensity curves.	COMPLETED	
9.	If considering Treatment BMPs, determine the soil classification, permeability, erodibility, and depth to groundwater.	COMPLETED	
10.	Determine contaminated or hazardous soils within the project area.	COMPLETED	

Please provide a description of the findings in the following box. For example:
The project is located in the San Diego Hydrologic unit. The area is characterized by rolling grassy hills and shrubs. Runoff from the project drains into a MS4 that eventually drains to Los Coches Creek. Within the project limit there are no 303(d) impaired receiving water and no Regional Board special requirements.

The project is located in the San Dieguito River Watershed and in the Rancho Santa Fe hydrologic unit (905.11). Drainage for this project will discharge to an existing drainage channel along Via Del La Valle that feeds into an unnamed tributary of the San Dieguito River. The project is approximately 1 mile from the San Dieguito River.

According to the California 2003 303d list published by the San Diego Regional Water Quality Control Board, the San Dieguito Lagoon Mouth in Solona Beach is the only impaired water body associated with this project.

The project lies in the Rancho Santa Fe hydrologic subarea, within the San Dieguito River hydrologic unit. Portions of this watershed are impaired for bacteria indicators.

The site is approximately 3 miles from this watershed.

Complete the checklist below to determine if Treatment Best Management Practices (BMPs) are required for the project.

No.	CRITERIA	YES	NO	INFORMATION
1.	Is this an emergency project		NO	If YES, go to 6. If NO, continue to 2.
2.	Have TMDLs been established	YES		If YES, go to 5.

No.	CRITERIA	YES	NO	INFORMATION
	for surface waters within the project limit?			If NO, continue to 3.
3.	Will the project directly discharge to a 303(d) impaired receiving water body?		NO	If YES, go to 5. If NO, continue to 4.
4.	Is this project within the urban and environmentally sensitive areas as defined on the maps in Appendix B of the *County of San Diego Standard Urban Storm Water Mitigation Plan for Land Development and Public Improvement Projects*?		NO	If YES, continue to 5. If NO, go to 6.
5.	Consider approved Treatment BMPs for the project.			If YES, go to 7.
6.	Project is not required to consider Treatment BMPs			Document for Project Files by referencing this checklist.
7.	End			

Now that the need for a treatment BMPs has been determined, other information is needed to complete the SWMP.

WATERSHED

Please check the watershed(s) for the project.

☐ San Juan	☐ Santa Margarita	☐ San Luis Rey	☐ Carlsbad
☒ San Dieguito	☐ Penasquitos	☐ San Diego	☐ Pueblo San Diego
☐ Sweetwater	☐ Otay	☐ Tijuana	

Please provide the hydrologic sub-area and number(s)

Number	Name
905.11	RANCHO SANTA FE

Please provide the beneficial uses for Inland Surface Waters and Ground Waters. Beneficial Uses can be obtained from the Water Quality Control Plan For The San Diego Basin, which is available at the Regional Board office or at http://www.swrcb.ca.gov/rwqcb9/programs/basinplan.html.

SURFACE WATERS	Hydrologic Unit Basin Number	MUN	AGR	IND	PROC	GWR	FRESH	POW	REC1	REC2	BIOL	WARM	COLD	WILD	RARE	SPWN
Inland Surface Waters	905.11								X	X	X			X	X	
Ground Waters	N/A															

X Existing Beneficial Use
0 Potential Beneficial Use
* Excepted from Municipal

POLLUTANTS OF CONCERN

Using Table 1, identify pollutants that are anticipated to be generated from the proposed priority project categories. Pollutants associated with any hazardous material sites that have been remediated or are not threatened by the proposed project are not considered a pollutant of concern.

Table 1. Anticipated and Potential Pollutants Generated by Land Use Type

	General Pollutant Categories								
Priority Project Categories	Sediments	Nutrients	Heavy Metals	Organic Compounds	Trash & Debris	Oxygen Demanding Substances	Oil & Grease	Bacteria & Viruses	Pesticides
Detached Residential Development	X	X			X	X	X	X	X
Attached Residential Development	X	X			X	p(1)	p(2)	p	X
Commercial Development >100,000 ft²	p(1)	p(1)		p(2)	X	p(5)	X	p(3)	p(5)
Automotive Repair Shops			X	X(4)(5)	X		X		
Restaurants					X	X	X	X	
Hillside Development >5,000 ft²	X	X			X	X	X		X

	General Pollutant Categories								
Priority Project Categories	Sediments	Nutrients	Heavy Metals	Organic Compounds	Trash & Debris	Oxygen Demanding Substances	Oil & Grease	Bacteria & Viruses	Pesticides
Parking Lots	P(1)	P(1)	X		X	P(1)	X		P(1)
Streets, Highways & Freeways	X	P(1)	X	X(4)	X	P(5)	X		

X = anticipated
P = potential
(1) A potential pollutant if landscaping exists on-site.
(2) A potential pollutant if the project includes uncovered parking areas.
(3) A potential pollutant if land use involves food or animal waste products.
(4) Including petroleum hydrocarbons.
(5) Including solvents.

Note: If other monitoring data that is relevant to the project is available. Please include as Attachment C.

CONSTRUCTION BMPs

Please check the construction BMPs that may be used. The BMPs selected are those that will be implemented during construction of the project. The applicant is responsible for the placement and maintenance of the BMPs selected.

- ☒ Silt Fence
- ☐ Desilting Basin
- ☐ Fiber Rolls
- ☒ Gravel Bag Berm
- ☒ Street Sweeping and Vacuuming
- ☐ Sandbag Barrier
- ☒ Storm Drain Inlet Protection
- ☒ Material Delivery and Storage
- ☒ Stockpile Management
- ☐ Spill Prevention and Control
- ☒ Solid Waste Management
- ☒ Concrete Waste Management
- ☒ Stabilized Construction Entrance/Exit
- ☒ Water Conservation Practices
- ☐ Dewatering Operations
- ☒ Paving and Grinding Operations
- ☒ Vehicle and Equipment Maintenance
- ☐ Any minor slopes created incidental to construction and not subject to a major or minor grading permit shall be protected by covering with plastic or tarp prior to a rain event, and shall have vegetative cover reestablished within 180 days of completion of the slope and prior to final building approval.

SITE DESIGN

To minimize stormwater impacts, site design measures must be addressed. The following checklist provides options for avoiding or reducing potential impacts during project planning. If

YES is checked, it is assumed that the measure was used for this project. If NO is checked, please provide a brief explanation why the option was not selected in the text box below.

	OPTIONS		YES	NO	N/A
1.	Can the project be relocated or realigned to avoid/reduce impacts to receiving waters or to increase the preservation of critical (or problematic) areas such as floodplains, steep slopes, wetlands, and areas with erosive or unstable soil conditions?		YES		
2.	Can the project be designed to minimize impervious footprint?		YES		
3.	Conserve natural areas where feasible?		YES		
4.	Where landscape is proposed, can rooftops, impervious sidewalks, walkways, trails and patios be drained into adjacent landscaping?		YES		
5.	For roadway projects, can structures and bridges be designed or located to reduce work in live streams and minimize construction impacts?				N/A
6.	Can any of the following methods be utilized to minimize erosion from slopes:				
	6.a.	Disturbing existing slopes only when necessary?	YES		
	6.b.	Minimize cut and fill areas to reduce slope lengths?	YES		
	6.c.	Incorporating retaining walls to reduce steepness of slopes or to shorten slopes?	YES		
	6.d.	Providing benches or terraces on high cut and fill slopes to reduce concentration of flows?	YES		
	6.e.	Rounding and shaping slopes to reduce concentrated flow?	YES		
	6.f.	Collecting concentrated flows in stabilized drains and channels?	YES		

Please provide a brief explanation for each option that was checked N/A or NO in the following box.

NOT A ROADWAY PROJECT

If the project includes work in channels, then complete the following checklist. Information shall be obtained from the project drainage report.

No.	CRITERIA	YES	NO	N/A	COMMENTS
1.	Will the project increase velocity or volume of downstream flow?	YES			If YES go to 5.
2.	Will the project discharge to unlined channels?				If YES go to 5.
3.	Will the project increase potential sediment load				If YES go to 5.

No.	CRITERIA	YES	NO	N/A	COMMENTS
	of downstream flow?				
4.	Will the project encroach, cross, realign, or cause other hydraulic changes to a stream that may affect upstream and/or downstream channel stability?				If YES go to 7.
5.	Review channel lining materials and design for stream bank erosion.		NO		Continue to 6.
6.	Consider channel erosion control measures within the project limits as well as downstream. Consider scour velocity.	YES			Continue to 7.
7.	Include, where appropriate, energy dissipation devices at culverts.	YES			Continue to 8.
8.	Ensure all transitions between culvert outlets/headwalls/wingwalls and channels are smooth to reduce turbulence and scour.	YES			Continue to 9.
9.	Include, if appropriate, detention facilities to reduce peak discharges.	YES	~~NO~~		
10.	"Hardening" natural downstream areas to prevent erosion is not an acceptable technique for protecting channel slopes, unless pre-development conditions are determined to be so erosive that hardening would be required even in the absence of the proposed development.	YES			Continue to 11.
11.	Provide other design principles that are comparable and equally effective.	YES			Continue to 12.
12.	End				

SOURCE CONTROL

Please complete the following checklist for Source Control BMPs. If the BMP is not applicable for this project, then check N/A only at the main category.

BMP			YES	NO	N/A
1.	**Provide Storm Drain System Stenciling and Signage**				
	1.a.	All storm drain inlets and catch basins within the project area shall have a stencil or tile placed with prohibitive language (such as: "NO DUMPING – DRAINS TO _____") and/or graphical icons to discourage illegal dumping.	YES		
	1.b.	Signs and prohibitive language and/or graphical icons, which prohibit illegal dumping, must be posted at public access points along channels and creeks within the project area.	YES		
2.	**Design Outdoors Material Storage Areas to Reduce Pollution Introduction**				
	2.a.	This is a detached single-family residential project. Therefore, personal storage areas are exempt from this requirement.	YES		

	BMP		YES	NO	N/A
	2.b.	Hazardous materials with the potential to contaminate urban runoff shall either be: (1) placed in an enclosure such as, but not limited to, a cabinet, shed, or similar structure that prevents contact with runoff or spillage to the storm water conveyance system; or (2) protected by secondary containment structures such as berms, dikes, or curbs.			N/A
	2.c.	The storage area shall be paved and sufficiently impervious to contain leaks and spills.			N/A
	2.d.	The storage area shall have a roof or awning to minimize direct precipitation within the secondary containment area.			N/A
3.	**Design Trash Storage Areas to Reduce Pollution Introduction**				
	3.a.	Paved with an impervious surface, designed not to allow run-on from adjoining areas, screened or walled to prevent off-site transport of trash; or,	YES		
	3.b.	Provide attached lids on all trash containers that exclude rain, or roof or awning to minimize direct precipitation.	YES		
4.	**Use Efficient Irrigation Systems & Landscape Design**				
	The following methods to reduce excessive irrigation runoff shall be considered, and incorporated and implemented where determined applicable and feasible.		YES		
	4.a.	Employing rain shutoff devices to prevent irrigation after precipitation.	YES		
	4.b.	Designing irrigation systems to each landscape area's specific water requirements.	YES		
	4.c.	Using flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.	YES		
	4.d.	Employing other comparable, equally effective, methods to reduce irrigation water runoff.	YES		
5.	**Private Roads**				
	The design of private roadway drainage shall use at least one of the following				
	5.a.	Rural swale system: street sheet flows to vegetated swale or gravel shoulder, curbs at street corners, culverts under driveways and street crossings.		NO	
	5.b.	Urban curb/swale system: street slopes to curb, periodic swale inlets drain to vegetated swale/biofilter.	YES		
	5.c.	Dual drainage system: First flush captured in street catch basins and discharged to adjacent vegetated swale or gravel shoulder, high flows connect directly to storm water conveyance system.		NO	
	5.d.	Other methods that are comparable and equally effective within the project.		NO	
6.	**Residential Driveways & Guest Parking**				
	The design of driveways and private residential parking areas shall use one at least of the following features.				
	6.a.	Design driveways with shared access, flared (single lane at street) or wheelstrips (paving only under tires); or, drain into landscaping prior to discharging to the storm water conveyance system.	YES		
	6.b.	Uncovered temporary or guest parking on private residential lots may be: paved with a permeable surface; or, designed to drain into landscaping prior to discharging to the storm water conveyance system.	YES		
	6.c.	Other features which are comparable and equally effective.	YES		
7.	**Dock Areas**				

	BMP		YES	NO	N/A
	Loading/unloading dock areas shall include the following.				
	7.a.	Cover loading dock areas, or design drainage to preclude urban run-on and runoff.			N/A
	7.b.	Direct connections to storm drains from depressed loading docks (truck wells) are prohibited.			N/A
	7.c.	Other features which are comparable and equally effective.			N/A
8.	**Maintenance Bays**				
	Maintenance bays shall include the following.				
	8.a.	Repair/maintenance bays shall be indoors; or, designed to preclude urban run-on and runoff.			N/A
	8.b.	Design a repair/maintenance bay drainage system to capture all wash water, leaks and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.			N/A
	8.c.	Other features which are comparable and equally effective.			N/A
9.	**Vehicle Wash Areas**				
	Priority projects that include areas for washing/steam cleaning of vehicles shall use the following.				N/A
	9.a.	Self-contained; or covered with a roof or overhang.			N/A
	9.b.	Equipped with a clarifier or other pretreatment facility.			N/A
	9.c.	Properly connected to a sanitary sewer.			N/A
	9.d.	Other features which are comparable and equally effective.			N/A
10.	**Outdoor Processing Areas**				N/A
	Outdoor process equipment operations, such as rock grinding or crushing, painting or coating, grinding or sanding, degreasing or parts cleaning, waste piles, and wastewater and solid waste treatment and disposal, and other operations determined to be a potential threat to water quality by the County shall adhere to the following requirements.				N/A
	10.a.	Cover or enclose areas that would be the most significant source of pollutants; or, slope the area toward a dead-end sump; or, discharge to the sanitary sewer system following appropriate treatment in accordance with conditions established by the applicable sewer agency.			
	10.b.	Grade or berm area to prevent run-on from surrounding areas.			N/A
	10.c.	Installation of storm drains in areas of equipment repair is prohibited.			N/A
	10.d.	Other features which are comparable or equally effective.			N/A
11.	**Equipment Wash Areas**				
	Outdoor equipment/accessory washing and steam cleaning activities shall be.				N/A
	11.a.	Be self-contained; or covered with a roof or overhang.			N/A
	11.b.	Be equipped with a clarifier, grease trap or other pretreatment facility, as appropriate			N/A
	11.c.	Be properly connected to a sanitary sewer.			N/A
	11.d.	Other features which are comparable or equally effective.			N/A
12.	**Parking Areas**				
	The following design concepts shall be considered, and incorporated and implemented where determined applicable and feasible by the County.				
	12.a.	Where landscaping is proposed in parking areas, incorporate landscape areas into the drainage design.			N/A

CATEGORY	SELECTED	
	YES	NO
First	YES	
Second	YES	
Third		
Fourth		

Please briefly describe the long-term fiscal resources for the selected maintenance mechanism(s).

~~The cost to construct the Bio-Filter swales is estimated at $1000 for grass installation per lot. Annual maintenance will be performed as part of normal landscaping operations. The cost for annual maintenance is estimated at $500/year lot. The homeowner will be responsible for the maintenance costs.~~ See attachments H and I.

ATTACHMENTS

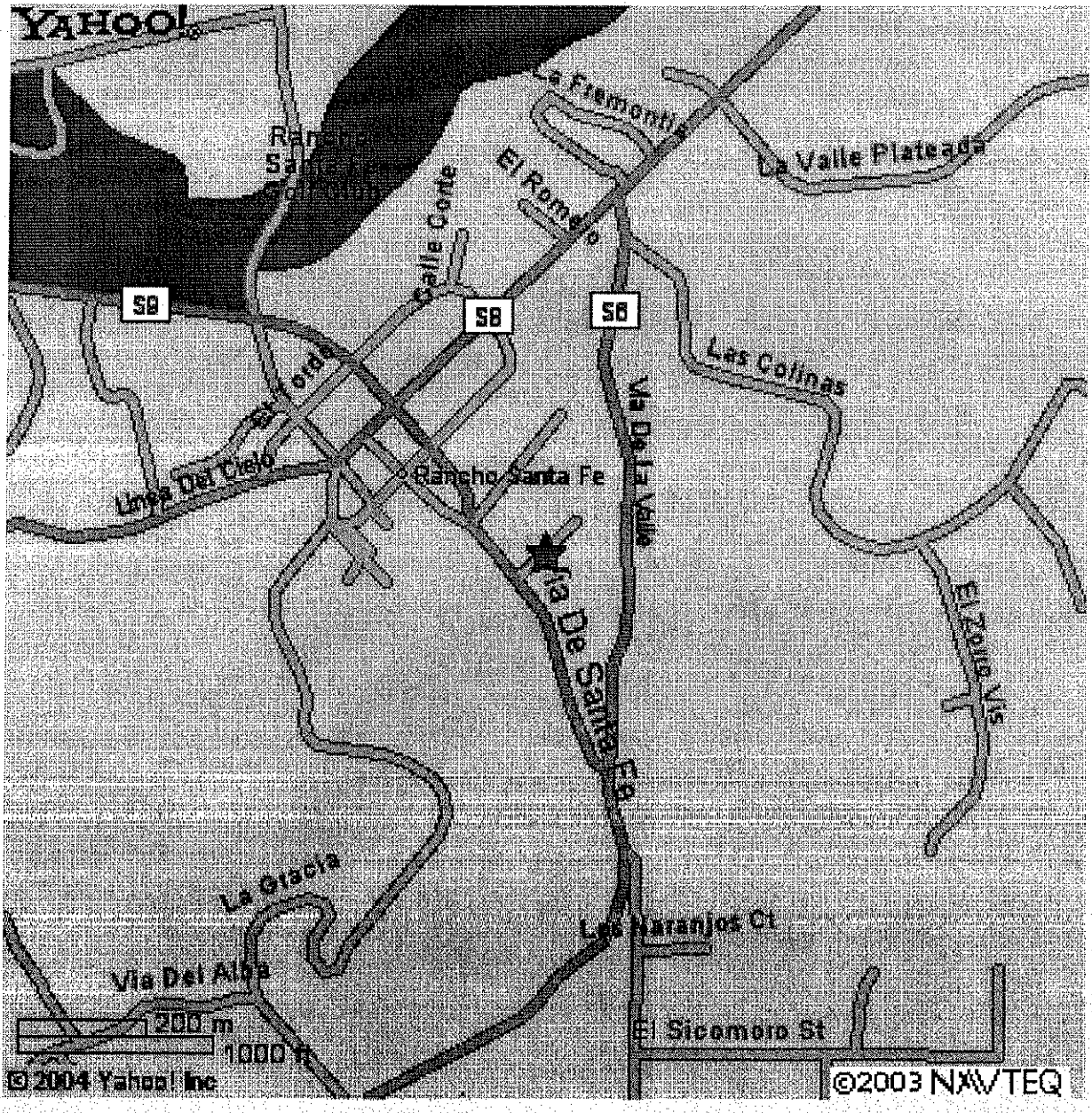
Please include the following attachments.

ATTACHMENT		COMPLETED	N/A
A	Project Location Map	COMPLETED	
B	Site Map	COMPLETED	
C	Relevant Monitoring Data	COMPLETED	
D	Treatment BMP Location Map	COMPLETED	
E	Treatment BMP Datasheets	COMPLETED	
F	Operation and Maintenance Program for Treatment BMPs	COMPLETED	
G	Engineer's Certification Sheet	COMPLETED	

Note: Attachments A and B may be combined.

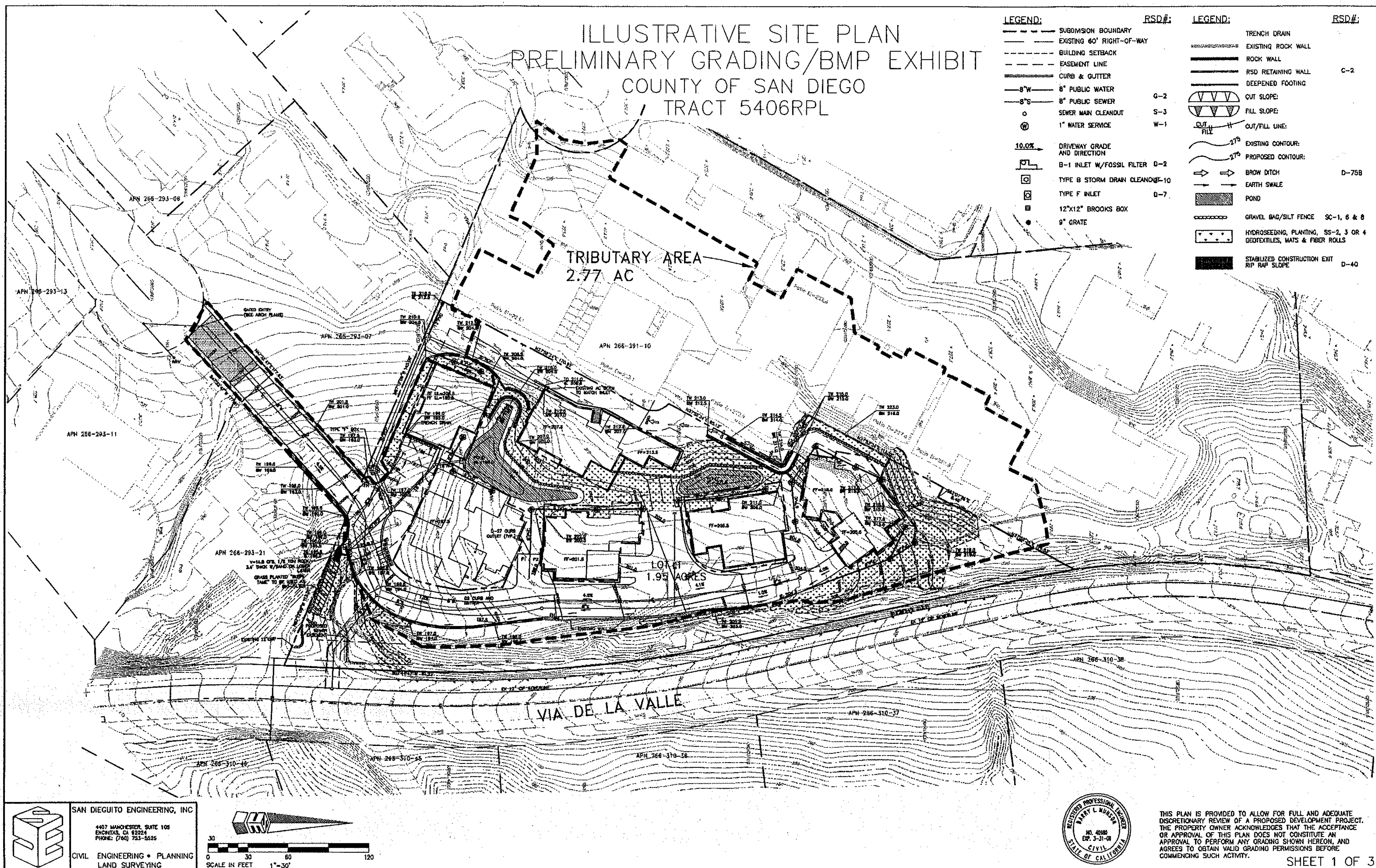
ATTACHMENT A

LOCATION MAP



ATTACHMENT B

PROJECT MAP



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ATTACHMENT C

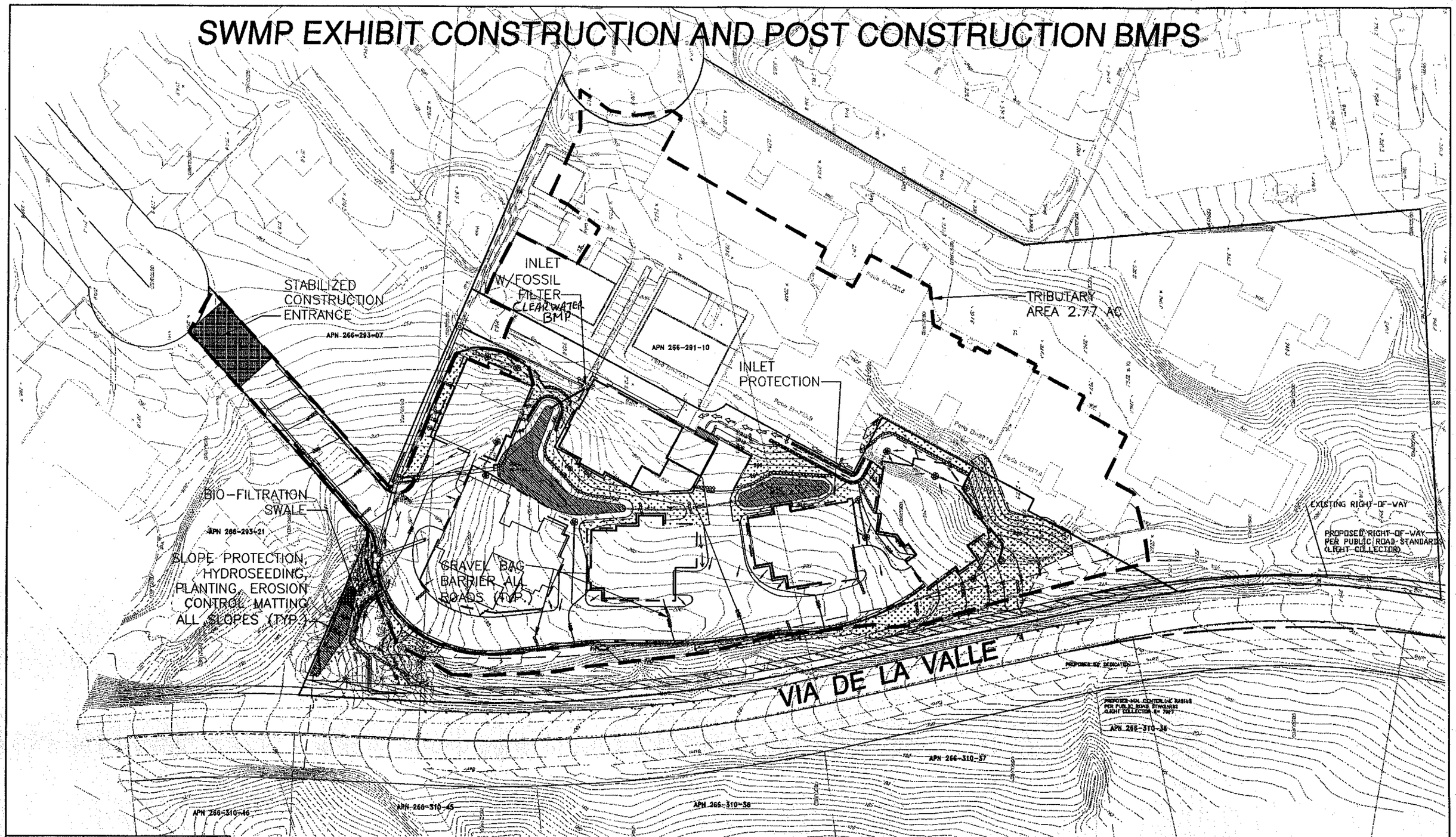
RELEVANT MONITORING DATA

*(**NOTE:** PROVIDE RELEVANT WATER QUALITY MONITORING DATA IF AVAILABLE)*

ATTACHMENT D

TREATMENT BMP LOCATION MAP

SWMP EXHIBIT CONSTRUCTION AND POST CONSTRUCTION BMPS



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LAND SURVEYING

NOTE: FINAL DETAILED DESIGN OF BMPS WILL OCCUR DURING FINAL PROJECT GRADING AND IMPROVEMENT PLAN PREPARATION

SCALE 1" = 60'

ATTACHMENT E

TREATMENT BMP DATA SHEET

*(**NOTE:** POSSIBLE SOURCE FOR DATA SHEETS CAN BE FOUND AT WWW.CABMPHANDBOOKS.COM. INCLUDE ENGINEERING CALCULATIONS FOR SIZING THE TREATMENT BMP)*

Pre

Outfall	Tributary Area (acres)	Q_{100} (cfs)
A1, A2, A3	7.9	22.8

Post (Using Basin Calculations)

Outfall	Tributary Area (acres)	Q_{100} (cfs)	*0.2"Flow Base (cfs)
C2, D1-D3, E1, F1	2.77	12.2	0.55

*(Bioswale) FLOWBASE=CIA= (1)(0.2in/hr)(A)

Pre Dev Basin	Area (SF)	Runoff (CFS)	Post Dev Basin	Area (SF)	Runoff(CFS)	Difference
A1,A2,A3	343688	22.8	B1,C1,C2,D1, D3, E1, F1	343688	22.2	-.6 CFS

Figure 1.0-Pre and Post Development Runoff comparison

Impervious Calculations			
	Imper Area	Total Area	%Imper
Basin A1,A2,A3	109082	343,688	31.7

Figure 2.0-Pre Development Impervious Calcs

Impervious Calculations			
	Imper Area	Total Area	%Imper
Basins B1,C1,C2,D1,D3,E1,F1	152499	343,688	42.3

Figure 3.0-Post Development Impervious Calcs

Vegetated Swale

TC-30

Design Considerations

- Tributary Area
- Area Required
- Slope
- Water Availability

Description

Vegetated swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Vegetated swales can serve as part of a stormwater drainage system and can replace curbs, gutters and storm sewer systems.

Targeted Constituents

☑	Sediment	▲
☑	Nutrients	●
☑	Trash	●
☑	Metals	▲
☑	Bacteria	●
☑	Oil and Grease	▲
☑	Organics	▲

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

California Experience

Caltrans constructed and monitored six vegetated swales in southern California. These swales were generally effective in reducing the volume and mass of pollutants in runoff. Even in the areas where the annual rainfall was only about 10 inches/yr, the vegetation did not require additional irrigation. One factor that strongly affected performance was the presence of large numbers of gophers at most of the sites. The gophers created earthen mounds, destroyed vegetation, and generally reduced the effectiveness of the controls for TSS reduction.

Advantages

- If properly designed, vegetated, and operated, swales can serve as an aesthetic, potentially inexpensive urban development or roadway drainage conveyance measure with significant collateral water quality benefits.

- Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible.

Limitations

- Can be difficult to avoid channelization.
- May not be appropriate for industrial sites or locations where spills may occur
- Grassed swales cannot treat a very large drainage area. Large areas may be divided and treated using multiple swales.
- A thick vegetative cover is needed for these practices to function properly.
- They are impractical in areas with steep topography.
- They are not effective and may even erode when flow velocities are high, if the grass cover is not properly maintained.
- In some places, their use is restricted by law: many local municipalities require curb and gutter systems in residential areas.
- Swales are mores susceptible to failure if not properly maintained than other treatment BMPs.

Design and Sizing Guidelines

- Flow rate based design determined by local requirements or sized so that 85% of the annual runoff volume is discharged at less than the design rainfall intensity.
- Swale should be designed so that the water level does not exceed 2/3rds the height of the grass or 4 inches, which ever is less, at the design treatment rate.
- Longitudinal slopes should not exceed 2.5%
- Trapezoidal channels are normally recommended but other configurations, such as parabolic, can also provide substantial water quality improvement and may be easier to mow than designs with sharp breaks in slope.
- Swales constructed in cut are preferred, or in fill areas that are far enough from an adjacent slope to minimize the potential for gopher damage. Do not use side slopes constructed of fill, which are prone to structural damage by gophers and other burrowing animals.
- A diverse selection of low growing, plants that thrive under the specific site, climatic, and watering conditions should be specified. Vegetation whose growing season corresponds to the wet season are preferred. Drought tolerant vegetation should be considered especially for swales that are not part of a regularly irrigated landscaped area.
- The width of the swale should be determined using Manning's Equation using a value of 0.25 for Manning's n.

Construction/Inspection Considerations

- Include directions in the specifications for use of appropriate fertilizer and soil amendments based on soil properties determined through testing and compared to the needs of the vegetation requirements.
- Install swales at the time of the year when there is a reasonable chance of successful establishment without irrigation; however, it is recognized that rainfall in a given year may not be sufficient and temporary irrigation may be used.
- If sod tiles must be used, they should be placed so that there are no gaps between the tiles; stagger the ends of the tiles to prevent the formation of channels along the swale or strip.
- Use a roller on the sod to ensure that no air pockets form between the sod and the soil.
- Where seeds are used, erosion controls will be necessary to protect seeds for at least 75 days after the first rainfall of the season.

Performance

The literature suggests that vegetated swales represent a practical and potentially effective technique for controlling urban runoff quality. While limited quantitative performance data exists for vegetated swales, it is known that check dams, slight slopes, permeable soils, dense grass cover, increased contact time, and small storm events all contribute to successful pollutant removal by the swale system. Factors decreasing the effectiveness of swales include compacted soils, short runoff contact time, large storm events, frozen ground, short grass heights, steep slopes, and high runoff velocities and discharge rates.

Conventional vegetated swale designs have achieved mixed results in removing particulate pollutants. A study performed by the Nationwide Urban Runoff Program (NURP) monitored three grass swales in the Washington, D.C., area and found no significant improvement in urban runoff quality for the pollutants analyzed. However, the weak performance of these swales was attributed to the high flow velocities in the swales, soil compaction, steep slopes, and short grass height.

Another project in Durham, NC, monitored the performance of a carefully designed artificial swale that received runoff from a commercial parking lot. The project tracked 11 storms and concluded that particulate concentrations of heavy metals (Cu, Pb, Zn, and Cd) were reduced by approximately 50 percent. However, the swale proved largely ineffective for removing soluble nutrients.

The effectiveness of vegetated swales can be enhanced by adding check dams at approximately 17 meter (50 foot) increments along their length (See Figure 1). These dams maximize the retention time within the swale, decrease flow velocities, and promote particulate settling. Finally, the incorporation of vegetated filter strips parallel to the top of the channel banks can help to treat sheet flows entering the swale.

Only 9 studies have been conducted on all grassed channels designed for water quality (Table 1). The data suggest relatively high removal rates for some pollutants, but negative removals for some bacteria, and fair performance for phosphorus.

Table 1 Grassed swale pollutant removal efficiency data

	Removal Efficiencies (% Removal)						
Study	TSS	TP	TN	NO_3	Metals	Bacteria	Type
Caltrans 2002	77	8	67	66	83-90	-33	dry swales
Goldberg 1993	67.8	4.5	-	31.4	42–62	-100	grassed channel
Seattle Metro and Washington Department of Ecology 1992	60	45	-	-25	2–16	-25	grassed channel
Seattle Metro and Washington Department of Ecology, 1992	83	29	-	-25	46–73	-25	grassed channel
Wang et al., 1981	80	-	-	-	70–80	-	dry swale
Dorman et al., 1989	98	18	-	45	37–81	-	dry swale
Harper, 1988	87	83	84	80	88–90	-	dry swale
Kercher et al., 1983	99	99	99	99	99	-	dry swale
Harper, 1988.	81	17	40	52	37–69	-	wet swale
Koon, 1995	67	39	-	9	-35 to 6	-	wet swale

While it is difficult to distinguish between different designs based on the small amount of available data, grassed channels generally have poorer removal rates than wet and dry swales, although some swales appear to export soluble phosphorus (Harper, 1988; Koon, 1995). It is not clear why swales export bacteria. One explanation is that bacteria thrive in the warm swale soils.

Siting Criteria

The suitability of a swale at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the swale system (Schueler et al., 1992). In general, swales can be used to serve areas of less than 10 acres, with slopes no greater than 5%. Use of natural topographic lows is encouraged and natural drainage courses should be regarded as significant local resources to be kept in use (Young et al., 1996).

Selection Criteria (NCTCOG, 1993)

- Comparable performance to wet basins
- Limited to treating a few acres
- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

The topography of the site should permit the design of a channel with appropriate slope and cross-sectional area. Site topography may also dictate a need for additional structural controls. Recommendations for longitudinal slopes range between 2 and 6 percent. Flatter slopes can be used, if sufficient to provide adequate conveyance. Steep slopes increase flow velocity, decrease detention time, and may require energy dissipating and grade check. Steep slopes also can be managed using a series of check dams to terrace the swale and reduce the slope to within acceptable limits. The use of check dams with swales also promotes infiltration.

Additional Design Guidelines

Most of the design guidelines adopted for swale design specify a minimum hydraulic residence time of 9 minutes. This criterion is based on the results of a single study conducted in Seattle, Washington (Seattle Metro and Washington Department of Ecology, 1992), and is not well supported. Analysis of the data collected in that study indicates that pollutant removal at a residence time of 5 minutes was not significantly different, although there is more variability in that data. Therefore, additional research in the design criteria for swales is needed. Substantial pollutant removal has also been observed for vegetated controls designed solely for conveyance (Barrett et al, 1998); consequently, some flexibility in the design is warranted.

Many design guidelines recommend that grass be frequently mowed to maintain dense coverage near the ground surface. Recent research (Colwell et al., 2000) has shown mowing frequency or grass height has little or no effect on pollutant removal.

Summary of Design Recommendations

1) The swale should have a length that provides a minimum hydraulic residence time of at least 10 minutes. The maximum bottom width should not exceed 10 feet unless a dividing berm is provided. The depth of flow should not exceed 2/3rds the height of the grass at the peak of the water quality design storm intensity. The channel slope should not exceed 2.5%.

2) A design grass height of 6 inches is recommended.

3) Regardless of the recommended detention time, the swale should be not less than 100 feet in length.

4) The width of the swale should be determined using Manning's Equation, at the peak of the design storm, using a Manning's n of 0.25.

5) The swale can be sized as both a treatment facility for the design storm and as a conveyance system to pass the peak hydraulic flows of the 100-year storm if it is located "on-line." The side slopes should be no steeper than 3:1 (H:V).

6) Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible. If flow is to be introduced through curb cuts, place pavement slightly above the elevation of the vegetated areas. Curb cuts should be at least 12 inches wide to prevent clogging.

7) Swales must be vegetated in order to provide adequate treatment of runoff. It is important to maximize water contact with vegetation and the soil surface. For general purposes, select fine, close-growing, water-resistant grasses. If possible, divert runoff (other than necessary irrigation) during the period of vegetation

establishment. Where runoff diversion is not possible, cover graded and seeded areas with suitable erosion control materials.

Maintenance

The useful life of a vegetated swale system is directly proportional to its maintenance frequency. If properly designed and regularly maintained, vegetated swales can last indefinitely. The maintenance objectives for vegetated swale systems include keeping up the hydraulic and removal efficiency of the channel and maintaining a dense, healthy grass cover.

Maintenance activities should include periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages. Cuttings should be removed from the channel and disposed in a local composting facility. Accumulated sediment should also be removed manually to avoid concentrated flows in the swale. The application of fertilizers and pesticides should be minimal.

Another aspect of a good maintenance plan is repairing damaged areas within a channel. For example, if the channel develops ruts or holes, it should be repaired utilizing a suitable soil that is properly tamped and seeded. The grass cover should be thick; if it is not, reseed as necessary. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals (e.g., silt, grass cuttings) must be disposed in accordance with local or State requirements. Maintenance of grassed swales mostly involves maintenance of the grass or wetland plant cover. Typical maintenance activities are summarized below:

- Inspect swales at least twice annually for erosion, damage to vegetation, and sediment and debris accumulation preferably at the end of the wet season to schedule summer maintenance and before major fall runoff to be sure the swale is ready for winter. However, additional inspection after periods of heavy runoff is desirable. The swale should be checked for debris and litter, and areas of sediment accumulation.
- Grass height and mowing frequency may not have a large impact on pollutant removal. Consequently, mowing may only be necessary once or twice a year for safety or aesthetics or to suppress weeds and woody vegetation.
- Trash tends to accumulate in swale areas, particularly along highways. The need for litter removal is determined through periodic inspection, but litter should always be removed prior to mowing.
- Sediment accumulating near culverts and in channels should be removed when it builds up to 75 mm (3 in.) at any spot, or covers vegetation.
- Regularly inspect swales for pools of standing water. Swales can become a nuisance due to mosquito breeding in standing water if obstructions develop (e.g. debris accumulation, invasive vegetation) and/or if proper drainage slopes are not implemented and maintained.

Cost

Construction Cost

Little data is available to estimate the difference in cost between various swale designs. One study (SWRPC, 1991) estimated the construction cost of grassed channels at approximately $0.25 per ft². This price does not include design costs or contingencies. Brown and Schueler (1997) estimate these costs at approximately 32 percent of construction costs for most stormwater management practices. For swales, however, these costs would probably be significantly higher since the construction costs are so low compared with other practices. A more realistic estimate would be a total cost of approximately $0.50 per ft², which compares favorably with other stormwater management practices.

Table 2 Swale Cost Estimate (SEWRPC, 1991)

Component	Unit	Extent	Unit Cost			Total Cost		
			Low	Moderate	High	Low	Moderate	High
Mobilization / Demobilization-Light	Swale	1	$107	$274	$441	$107	$274	$441
Site Preparation								
Clearing[b]	Acre	0.5	$2,200	$3,800	$5,400	$1,100	$1,900	$2,700
Grubbing[c]	Acre	0.25	$3,800	$5,200	$8,600	$950	$1,300	$1,650
General Excavation[d]	Yd^3	372	$2.10	$3.70	$5.30	$781	$1,376	$1,972
Level and Till[e]	Yd^2	1,210	$0.20	$0.35	$0.50	$242	$424	$605
Sites Development								
Salvaged Topsoil	Yd^2	1,210	$0.40	$1.00	$1.60	$484	$1,210	$1,936
Seed, and Mulch[f]	Yd^2	1,210	$1.20	$2.40	$3.60	$1,452	$2,904	$4,356
Sod[g]								
Subtotal	--	--	--	--	--	$5,116	$9,368	$13,660
Contingencies	Swale	1	25%	25%	25%	$1,279	$2,347	$3,415
Total	--	--	--	--	--	$6,395	$11,735	$17,075

Source: (SEWRPC, 1991)

Note: Mobilization/demobilization refers to the organization and planning involved in establishing a vegetative swale.

[a] Swale has a bottom width of 1.0 foot, a top width of 10 feet with 1:3 side slopes, and a 1,000-foot length.

[b] Area cleared = (top width + 10 feet) x swale length.

[c] Area grubbed = (top width x swale length).

[d] Volume excavated = (0.67 x top width x swale depth) x swale length (parabolic cross-section).

[e] Area tilled = $\left(\text{top width} + \frac{8(\text{swale depth}^2)}{3(\text{top width})}\right)$ x swale length (parabolic cross-section).

[f] Area seeded = area cleared x 0.5.

[g] Area sodded = area cleared x 0.5.

Table 3 Estimated Maintenance Costs (SEWRPC, 1991)

Component	Unit Cost	Swale Size (Depth and Top Width)		Comment
		1.5 Foot Depth, One-Foot Bottom Width, 10-Foot Top Width	3-Foot Depth, 3-Foot Bottom Width, 21-Foot Top Width	
Lawn Mowing	$0.85 / 1,000 ft²/ mowing	$0.14 / linear foot	$0.21 / linear foot	Lawn maintenance area=(top width + 10 feet) x length. Mow eight times per year
General Lawn Care	$9.00 / 1,000 ft²/ year	$0.18 / linear foot	$0.28 / linear foot	Lawn maintenance area = (top width + 10 feet) x length
Swale Debris and Litter Removal	$0.10 / linear foot / year	$0.10 / linear foot	$0.10 / linear foot	--
Grass Reseeding with Mulch and Fertilizer	$0.30 / yd²	$0.01 / linear foot	$0.01 / linear foot	Area revegetated equals 1% of lawn maintenance area per year
Program Administration and Swale Inspection	$0.15 / linear foot / year, plus $25 / inspection	$0.15 / linear foot	$0.15 / linear foot	Inspect four times per year
Total	--	$0.58 / linear foot	$ 0.75 / linear foot	--

Maintenance Cost

Caltrans (2002) estimated the expected annual maintenance cost for a swale with a tributary area of approximately 2 ha at approximately $2,700. Since almost all maintenance consists of mowing, the cost is fundamentally a function of the mowing frequency. Unit costs developed by SEWRPC are shown in Table 3. In many cases vegetated channels would be used to convey runoff and would require periodic mowing as well, so there may be little additional cost for the water quality component. Since essentially all the activities are related to vegetation management, no special training is required for maintenance personnel.

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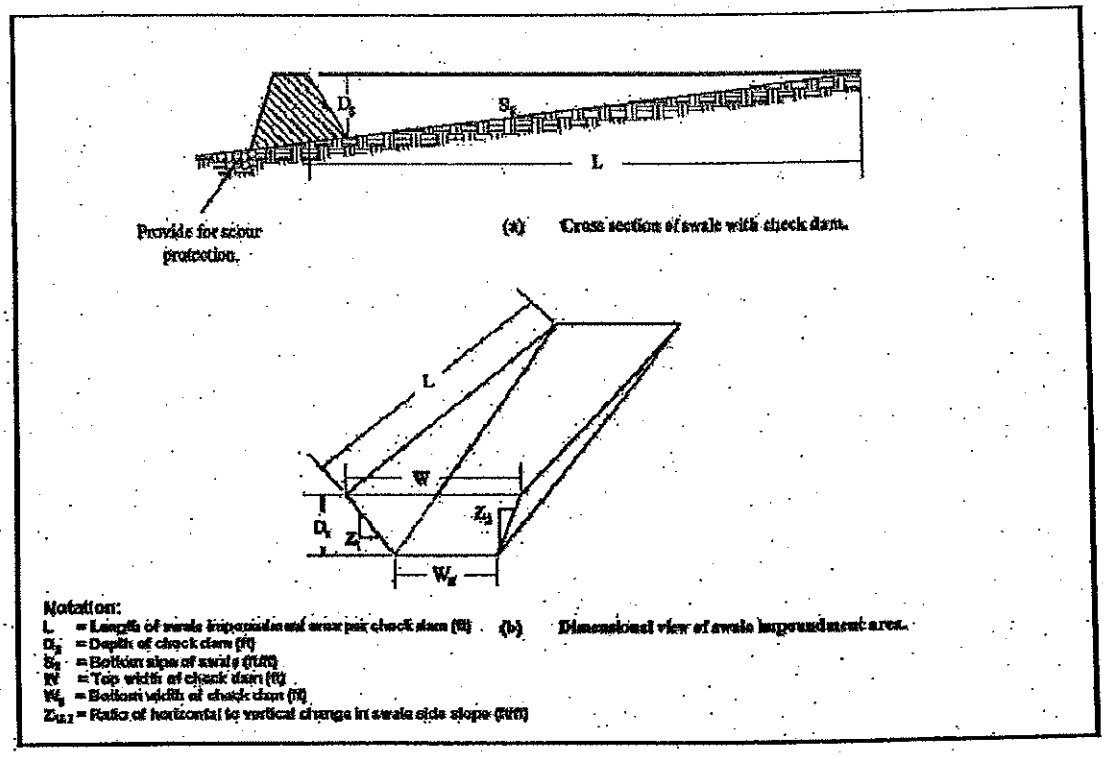

Notation:
L = Length of swale impoundment area per check dam (ft)
D_c = Depth of check dam (ft)
S_s = Bottom slope of swale (ft/ft)
W = Top width of check dam (ft)
W_d = Bottom width of check dam (ft)
$Z_{2:1}$ = Ratio of horizontal to vertical change in swale side slope (ft/ft)

ATTACHMENT F

OPERATION AND MAINTENANCE PROGRAM FOR TREATMENT BMP

(Note: INFORMATION REGARDING OPERATION AND MAINTENANCE CAN BE OBTAINED FROM THE FOLLOWING WEBSITE:
HTTP://WWW.SDCOUNTY.CA.GOV/DPW/WATERSHEDS/LAND_DEV/SUSMP.HTML)

1.0 OPERATION AND MAINTENANCE PROGRAM

The operation and maintenance requirements for each type of BMP are as follows:

1.1 Bio-Filters

The operation and maintenance requirements of a swale are as follows:

- Vegetation management to maintain adequate hydraulic functioning ant to limit habitat for disease carrying animals.
- Animal and vector control.
- Periodic sediment removal to optimize performance.
- Trash, debris, grass trimmings, tree pruning, and leaf collection and removal to prevent obstruction of the swale.
- Removal of standing water, which may contribute to the development of aquatic plant communities or mosquito breeding areas.
- Removal of graffiti.
- Preventative maintenance of BMP equipment and structures.
- Erosion and structural maintenance to prevent the loss of soil and maintain the performance of the swale.

Inspection Frequency

The facility will be inspected and inspection visits will be completely documented:

- Once a month at a minimum.
- After every large storm (storms with more than 0.5 inches of precipitation).
- Weekly during extended periods of wet weather.

Aesthetic and Functional Maintenance

Aesthetic maintenance is important for public acceptance of stormwater facilities.
Functional maintenance is important for performance and safety reasons.
Both forms of maintenance will be combined into an overall Stormwater Management

Aesthetic Maintenance

The following activities will be included in the aesthetic maintenance program:

- Graffiti Removal. Graffiti will be removed in a timely manner to improve the appearance of a Swale and to discourage additional graffiti or other acts of vandalism.
- Grass trimming. Trimming of grass will be done on the Swale, around fences, at the inlet and outlet structures, and sampling structures.
- Weed Control Weeds will be removed through mechanical means. Herbicide will not be used because these chemicals may impact the water quality monitoring.

Functional Maintenance

Functional maintenance has two components:

- Preventive maintenance
- Corrective maintenance

Preventive Maintenance

Preventive maintenance activities to be instituted at a Swale are:

- Grass Mowing. Vegetation seed mix within the Swale is designed to be kept short to maintain adequate hydraulic functioning and to limit the development of faunal habitats.
- Trash and Debris. During each inspection and maintenance visit to the site, debris and trash removal will be conducted to reduce the potential for inlet and outlet structures and other components from becoming clogged and inoperable during storm events.
- Sediment Removal. Sediment accumulation, as part of the operation and maintenance program at a Swale, will be monitored once a month during the dry season, after every large storm (0.5 inch), and monthly during the wet season. Specifically, if sediment reaches a level at or near plant height, or could interfere with flow or operation, the sediment will be removed. If accumulation of debris or sediment is determined to be the cause of decline in design performance, prompt action (i.e., within ten working days) will be taken to restore the swale to design performance standards. Actions will include using additional fill and vegetation and/or removing accumulated sediment to correct channeling or ponding. Characterization and Appropriate disposal of sediment will comply with applicable local, county, state, or federal requirements. The swale will be regraded, if the flow gradient has changed, and then replanted with sod.
- Removal of Standing Water. Standing water must be removed if it contributes to the development of aquatic plant communities or mosquito breeding areas.
- Mechanical and Electronic Components. Regularly scheduled maintenance will be performed on fences, gates, locks, and sampling and monitoring equipment in accordance with the manufacturers' recommendations. Electronic and mechanical components will be operated during each maintenance inspection to assure continued performance.
- Fertilization and Irrigation. The vegetation seed mix has been designed so that fertilization and irrigation is not necessary. Fertilizers and irrigation will not be used to maintain the vegetation.
- Elimination of Mosquito Breeding Habitats. The most effective mosquito control program is one that eliminates potential breeding habitats.

Corrective Maintenance

Corrective maintenance is required on an emergency or non-routine basis to correct problems and to restore the intended operation and safe function of a Swale. Corrective maintenance activities include:

- Removal of Debris and Sediment. Sediment, debris, and trash, which impede the hydraulic functioning of a Swale and prevent vegetative growth, will be removed and properly disposed. Temporary arrangements will be made for handling the sediments until a permanent arrangement is made. Vegetation will be re-established after sediment removal.

- Structural Repairs. Once deemed necessary, repairs to structural components of a Swale and its inlet and outlet structures will be done within 10 working days. Qualified individuals (i.e., the designers or contractors) will conduct repairs where structural damage has occurred.
- Embankment and Slope Repairs. Once deemed necessary, damage to the embankments and slopes of Swales will be repaired within 10 working days).
- Erosion Repair. Where a reseeding program has been ineffective, or where other factors have created erosive conditions (i.e., pedestrian traffic, concentrated flow, etc.), corrective steps will be taken to prevent loss of soil and any subsequent danger to the performance of a Swale. There are a number of corrective actions than can be taken. These include erosion control blankets, rip rap, sodding, or reduced flow through the area. Designers or contractors will be consulted to address erosion problems if the solution is not evident.
- Fence Repair. Repair of fences will be done within 30 days to maintain the security of the site.
- Elimination of Animal Burrows. Animal burrows will be filled and steps taken to remove the animals if burrowing problems continue to occur (filling and compacting). If the problem persists, vector control specialists will be consulted regarding removal steps. This consulting is necessary as the threat of rabies in some areas may necessitate the animals being destroyed rather than relocated. If the BMP performance is affected, abatement will begin. Otherwise, abatement will be performed annually in September.
- General Facility Maintenance. In addition to the above elements of corrective maintenance, general corrective maintenance will address the overall facility and its associated components. If corrective maintenance is being done to one component, other components will be inspected to see if maintenance is needed.

Maintenance Frequency

Section 5.1 lists the schedule of maintenance activities to be implemented at a Swale.

Debris and Sediment Disposal
Waste generated at swales is ultimately the responsibility of the owner. Disposal of sediment, debris, and trash will comply with applicable local, county, state, and federal waste control programs.

Hazardous Waste

Suspected hazardous wastes will be analyzed to determine disposal options. Hazardous wastes generated onsite will be handled and disposed of according to applicable local, state, and federal regulations. A solid or liquid waste is considered a hazardous waste if it exceeds the criteria listed in the CCR, Title 22, Article 11.

County of San Diego

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November 28, 2005

Stewart McClure
Clearwater Solutions, Inc.
2259 Lone Oak Lane
Vista, Ca 92084

Dear Mr. McClure:

CLEARWATER SOLUTION FOR USE IN THE COUNTY OF SAN DIEGO

The County of San Diego (County) has reviewed your inquiry regarding the approval of ClearWater Solution™ Best Management Practice (BMP) for use in the County of San Diego.

Since the County regulates the use of structural treatment control BMPs only in the unincorporated portions of the County, this response has no applicability to projects located within incorporated cities in the County. Furthermore, the County does not endorse this product.

After reviewing the information provided to the County, ClearWater Solution™ BMP shall be accepted for use as a structural treatment BMP under the category of filtration system. This decision is based on test results from San Diego State University.

Thank you for informing the County about your product. If you have any questions or need additional information, please contact Cid Tesoro, Flood Control Engineer, at (858) 694-3672, or e-mail at Cid.Tesoro@sdcounty.ca.gov.

Sincerely,

for CHANDRA L. WALLAR
Assistant Director

cc: Cid Tesoro (O326)

WHAT IS YOUR NPDES COMPLIANCE CRITERIA?

Typical Street Right-of-way for:

ClearWater BMP Treatment Capacity

Rainfall Intensity, Inches/Hr	0.20	0.25	0.50	0.75	1.0
R.O.W. Treatment Capacity, Acres	2.5	2.0	1.0	0.67	0.50

*** treatment capacity = 200 gpm before flow bypassing occurs .46 cfs**

ClearWater BMP Design Consideration	Feature Specifications	Benefits
Targeting Urban Retrofit and New Development: Impervious surface runoff capture and treatment area equivalent .	Filters up to 1.5" of rain per hour. At .50" of rain per hour unit can handle 43,560 square feet of drainage (1 acre).	Conserves land for other uses; optimizes land use where space is at a premium, e.g., urban retrofit.
Flow Thru Design Limits:		
Continuous flow-thru design limit	200 gpm (based on a 5/8" weir opening)	Exceeds NPDES criteria for "first flush".
Overflow flow-thru to flood system	250 gpm (based on a _" weir opening)	No clogging of stormdrains.
Primary Chamber Capacity	Coarse Settling 5.5 cf capacity	Cover and Back-panel Baffle ensures that it never scours/re-suspends sediments.
Secondary Chamber Capacity	Fine Settling	_" to 5/8" submerged neck-down between chambers ensures stilling and sedimentation.
Final Chamber	Soluable Filtering	Soluable Filtration including Bacteria.
Filter Media: • Perlite-zeolite mix • AbTec panel smart sponge (option) • Rubberizer oil-sock • Fish Filter pad	Targeting: • Metals, emulsified hydrocarbons, organics (chlorine, ammonia) • Pathogens • Floating hydrocarbons • Larger diameter suspended solids	• Pollution reduction at/near the source. • Removal efficiencies: 97% TSS, 86% Oil and Grease (O&G), 81% for lead (Pb), 83% for Zinc (Zn). • Satisfactory rates for heavy metals in solution.
Maintenance Requirements: • Filter media • Sediment removal	As required. Can be done from the curb using shop vac and generator or pumper truck.	Does not require sophisticated system. Is accessed from the curb.
Fabrication Materials	.304 gauge stainless steel, 16 GA	Won't corrode.
Outside Dimensions	30" wide; 30" high at rear-tapers to 20" at front, 34" front to back including trash hoops and nets.	
Assembly	Assembles inside existing drain box.	Can be retrofitted to older systems if box is large enough. Narrower Model is available.
Mosquito Free	Self-draining	Presents no health hazard.
Water Capture: 100% (at 200 gpm with 5/8" weir opening)	Design brings all water through the system; water tight seals between wall of drain box and filter.	Treats all water; captures all trash.

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The ClearWater BMP is a Filtration System!

Structural Treatment Control BMP Selection Matrix

Pollutant of Concern	Treatment Control BMP Categories						
	Biofilters	Detention Basins	Infiltration Basins	Wet Ponds or Wetlands	Drainage Inserts	**Filtration**	Hydrodynamic Separator Systems
Sediment	M	H	H	H	L	**H**	M
Nutrients	L	M	M	M	L	**M**	L
Heavy Metals	M	M	M	H	L	**H**	L
Organic Compounds	U	U	U	U	L	**M**	L
Trash & Debris	L	H	U	U	M	**H**	M
Oxygen Demanding Substances	L	M	M	M	L	**M**	L
Bacteria	U	U	H	U	L	**M**	L
Oil & Grease	M	M	U	U	L	**H**	L
Pesticides	U	U	U	U	L	**U**	L

(1) Including trenches and porous pavement.
(2) Also known as hydrodynamic devices and baffle boxes.

L: Low removal efficiency
M: Medium removal efficiency
H: High Removal efficiency
U: Unknown removal efficiency

Sources: Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (1993), National Stormwater Best Management Practices Database (2001), and Guide for BMP Selection in Urban Developed Areas (2001).

The ClearWater BMP Curb Inlet Filter

The ClearWater BMP is a powerful advancement in sidewalk curb inlet filtration technology. The patent-pending, filter train design allows stormwater flows to be screened, settled, and then filtered, all within the confines of an existing curb inlet drain box. This aggressive filtration design significantly reduces concentrations of trash, sediment, hydrocarbons, metals, and nutrients. Specifically designed for retrofitting within the existing curb and gutter infrastructure, it handles heavy storm flows with ease, dry-weather flows expertly, utilizes mosquito free technology and requires no excavation or concrete modification. The ClearWater BMP truly is your curb inlet pollution solution.

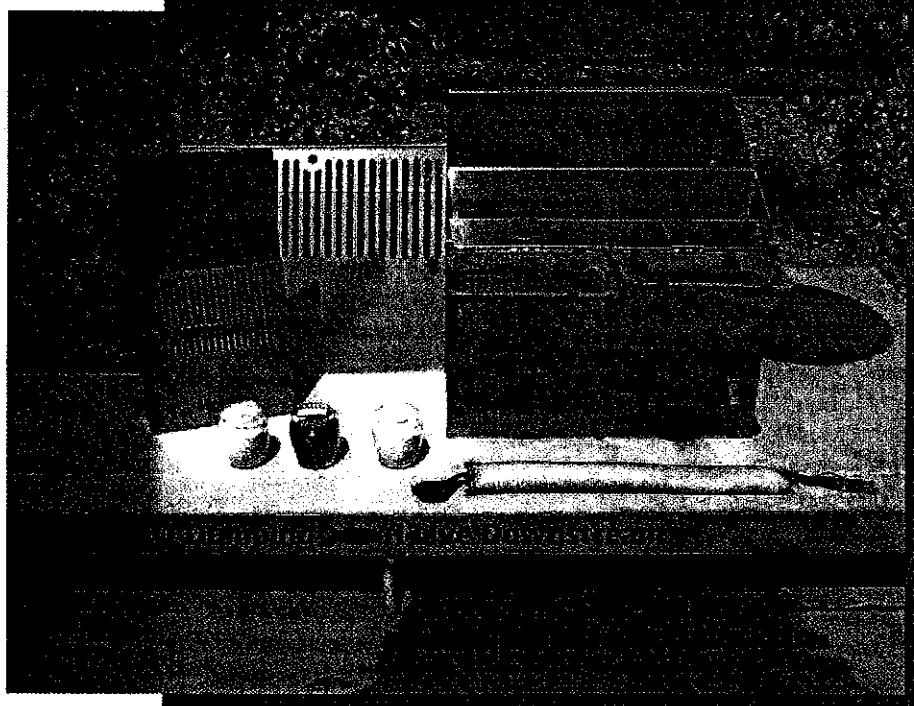
Features

- Fits into existing curb inlets
- Non-scouring
- Large storage capacity
- Easy street level maintenance
- No clogging under heavy flows
- Durable stainless steel construction
- Affordable

Benefits

- Improves downstream water quality
- High removal rate of Total Suspended Solids – 97%
- Located close to pollutant sources
- Reduces concentrations of trash, sediment, hydrocarbons, metals and nutrients
- NPDES Compliant – now and in the future

ClearWater BMP



Patent Pending

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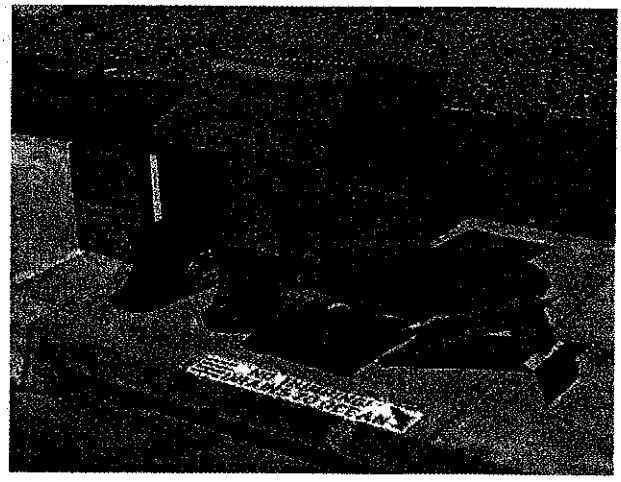
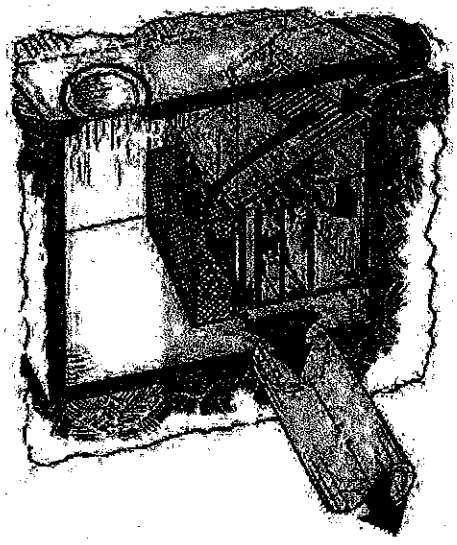
System Operation



The ClearWater BMP is a powerful advancement in sidewalk curb inlet filtration technology. Specifically designed for retrofitting under the sidewalk within the curb and gutter system, it handles heavy storm flows with ease, utilizes mosquito free technology, and requires no excavation or concrete modification.

The revolutionary design of the ClearWater BMP allows storm water to be screened three times, settled three times, make constant surface contact with an oil and grease separator, pass through a synthetic mesh filter, and finally pass through a column of porous media comprised of natural zeolites, perlite, and activated carbon. Filter media can be tailored to site specific needs. These media and the unique engineering design of the filter support containing them, enhances removal of smaller particulates, thus improving the quality of life downstream.



Performance Testing

Using the "typical" storm water calculations of 0.2 inches (3,780 gallons) of rain per hour for an ordinary curb inlet, the ClearWater BMP performed very well. Proven testing from San Diego State University shows the ClearWater BMP has removal rates of 97% for total suspended solids (TSS), 86% for oil and grease (O & G), 81% for lead (Pb), and 83% for zinc (Zn). Satisfactory rates of removal were accomplished with heavy metals in solution, a claim that will not be found in most competitors literature since most only clean out larger settled constituents, while the finer materials flow downstream contaminating wildlife and beaches.

Removal with Mixed-Media Filter at 64 GPM

	Typical % Removal with ClearWater BMP
TSS: Total Suspended Solids	97
O&G: Oil & Grease	86
Pb: Lead	81
Zn: Zinc	83

What is your NPDES compliance criteria?

ClearWater BMP Treatment Capacity					
Rainfall Intensity, Inches/Hr.	0.20	0.25	0.50	0.75	1.0
R.O.W. Treatment Capacity, Acres	2.5	2.0	1.0	0.67	0.50

200 GPM (.46 CFS) before bypassing occurs.

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Table 1 California Wetland Vegetation	
Botanical Name	**Common Name**
BACCHARIS SALICIFOLIA	MULE FAT
FRANKENIA GRANDIFOLIA	HEATH
SALIX GOODINGII	BLACK WILLOW
SALIX LASIOLEPIS	ARROYO WILLOW
SAMUCUS MEXICANUS	MEXICAN ELDERBERRY
HAPLOPAPPUS VENETUS	COAST GOLDENBRUSH
DISTICHIS SPICATA	SALT GRASS
LIMONIUM CALIFORNICUM	COASTAL STATICE
ATRIPLEX LENTIFORMIS	COASTAL QUAIL BUSH
BACCHARIS PILULARIS	CHAPARRAL BROOM
MIMULUS LONGIFLORUS	MONKEY FLOWER
SCIRPUS CALIFORNICUS	BULRUSH
SCIRPUS ROBUSTUS	BULRUSH
TYPHA LATIFOLIA	BROADLEAF CATTAIL
JUNCUS ACUTUS	RUSH

Maintenance

The amount of maintenance required for a wet pond is highly dependent on local regulatory agencies, particular health and vector control agencies. These agencies are often extremely concerned about the potential for mosquito breeding that may occur in the permanent pool. Even though mosquito fish (*Gambusia affinis*) were introduced into a wet pond constructed by Caltrans in the San Diego area, mosquito breeding was routinely observed during inspections. In addition, the vegetation at this site became sufficiently dense on the bench around the edge of the pool that mosquito fish were unable to enter this area to feed upon the mosquito larvae. The vegetation at this site was particularly vigorous because of the high nutrient concentrations in the perennial base flow (15.5 mg/L NO3-N) and the mild climate, which permitted growth year round. Consequently, the vector control agency required an annual harvest of vegetation to address this situation. This harvest can be very expensive.

On the other hand, routine harvesting may increase nutrient removal and prevent the export of these constituents from dead and dying plants falling in the water. A previous study (Faulkner and Richardson, 1991) documented dramatic reductions in nutrient removal after the first several years of operation and related it to the vegetation achieving a maximum density. That content then decreases through the growth season, as the total biomass increases. In effect, the total amount of

nutrients/m2 of wetland remains essentially the same from June through September, when the plants start to put the P back into the rhizomes. Therefore harvesting should occur between June and September. Research also suggests that harvesting only the foliage is less effective, since a very small percentage of the removed nutrients is taken out with harvesting.

Since wet ponds are often selected for their aesthetic considerations as well as pollutant removal, they are often sited in areas of high visibility. Consequently, floating litter and debris are removed more frequently than would be required simply to support proper functioning of the pond and outlet. This is one of the primary maintenance activities performed at the Central Market Pond located in Austin, Texas. In this type of setting, vegetation management in the area surrounding the pond can also contribute substantially to the overall maintenance requirements.

One normally thinks of sediment removal as one of the typical activities performed at stormwater BMPs. This activity does not normally constitute one of the major activities on an annual basis. At the concentrations of TSS observed in urban runoff from stable watersheds, sediment removal may only be required every 20 years or so. Because this activity is performed so infrequently, accurate costs for this activity are lacking.

In addition to regular maintenance activities needed to maintain the function of wet ponds, some design features can be incorporated to ease the maintenance burden. In wet ponds, maintenance reduction features include techniques to reduce the amount of maintenance needed, as well as techniques to make regular maintenance activities easier.

One potential maintenance concern in wet ponds is clogging of the outlet. Ponds should be designed with a non-clogging outlet such as a reverse-slope pipe, or a weir outlet with a trash rack. A reverse-slope pipe draws from below the permanent pool extending in a reverse angle up to the riser and establishes the water elevation of the permanent pool. Because these outlets draw water from below the level of the permanent pool, they are less likely to be clogged by floating debris.

Typical maintenance activities and frequencies include:

- Schedule semiannual inspections for burrows, sediment accumulation, structural integrity of the outlet, and litter accumulation.
- Remove accumulated trash and debris in the basin at the middle and end of the wet season. The frequency of this activity may be altered to meet specific site conditions and aesthetic considerations.
- Where permitted by the Department of Fish and Game or other agency regulations, stock wet ponds/constructed wetlands regularly with mosquito fish (*Gambusia spp.*) to enhance natural mosquito and midge control.
- Introduce mosquito fish and maintain vegetation to assist their movements to control mosquitoes, as well as to provide access for vector inspectors. An annual vegetation harvest in summer appears to be optimum, in that it is after the bird breeding season, mosquito fish can provide the needed control until vegetation reaches late summer density, and there is time for re-growth for runoff treatment purposes before the wet season. In certain cases, more frequent plant harvesting may be required by local vector control agencies.

- Maintain emergent and perimeter shoreline vegetation as well as site and road access to facilitate vector surveillance and control activities.
- Remove accumulated sediment in the forebay and regrade about every 5-7 years or when the accumulated sediment volume exceeds 10 percent of the basin volume. Sediment removal may not be required in the main pool area for as long as 20 years.

Cost

Construction Cost

Wet ponds can be relatively inexpensive stormwater practices; however, the construction costs associated with these facilities vary considerably. Much of this variability can be attributed to the degree to which the existing topography will support a wet pond, the complexity and amount of concrete required for the outlet structure, and whether it is installed as part of new construction or implemented as a retrofit of existing storm drain system.

A recent study (Brown and Schueler, 1997) estimated the cost of a variety of stormwater management practices. The study resulted in the following cost equation, adjusting for inflation:

$$C = 24.5^{V0.705}$$

where:

C = Construction, design and permitting cost;

V = Volume in the pond to include the 10-year storm (ft^3).

Using this equation, typical construction costs are:

$45,700 for a 1 acre-foot facility

$232,000 for a 10 acre-foot facility

$1,170,000 for a 100 acre-foot facility

In contrast, Caltrans (2002) reported spending over $448,000 for a pond with a total permanent pool plus water quality volume of only 1036 m^3 (0.8 ac.-ft.), while the City of Austin spent $584,000 (including design) for a pond with a permanent pool volume of 3,100 m^3 (2.5 ac.-ft.). The large discrepancies between the costs of these actual facilities and the model developed by Brown and Schueler indicate that construction costs are highly site specific, depending on topography, soils, subsurface conditions, the local labor, rate and other considerations.

Maintenance Cost

For ponds, the annual cost of routine maintenance has typically been estimated at about 3 to 5 percent of the construction cost; however, the published literature is almost totally devoid of actual maintenance costs. Since ponds are long-lived facilities (typically longer than 20 years), major maintenance activities are unlikely to occur during a relatively short study.

Caltrans (2002) estimated annual maintenance costs of $17,000 based on three years of monitoring of a pond treating runoff from 1.7 ha. Almost all the activities are associated with the annual vegetation harvest for vector control. Total cost at this site falls within the 3-5% range reported

above; however, the construction costs were much higher than those estimated by Brown and Schueler (1997). The City of Austin has been reimbursing a developer about $25,000/yr for wet pond maintenance at a site located at a very visible location. Maintenance costs are mainly the result of vegetation management and litter removal. On the other hand, King County estimates annual maintenance costs at about $3,000 per pond; however, this cost likely does not include annual extensive vegetation removal. Consequently, maintenance costs may vary considerably at sites in California depending on the aggressiveness of the vegetation management in that area and the frequency of litter removal.

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ATTACHMENT H-Mechanisms to Assure Maintenance

FIRST CATEGORY:
The County should have only minimal concern for ongoing maintenance. The proposed BMPs inherently "take care of themselves", or property owners can naturally be expected to do so as an incident of taking care of their property

Typical BMPs:
☐ Biofilters (Grass swale, Grass strip, vegetated buffer)
☐ Infiltration BMP (basin, trench);

For TM 5406 First Category BMPs are: grass swales as shown on the BMP map that is a part of this SWMP. These BMP's will be maintained by the homeowner and/or the HOA as a part of their regular property maintenance. Annual maintenance is estimated at $1,249.58 per Appendix H of the SUSMP Manual.

Funding:
None Required.

Mechanisms to Assure Maintenance
See notes 1 through 5 on following page.

SECOND CATEGORY:
The County needs to assure ongoing maintenance. The nature of the proposed BMPs indicates that it is appropriate for property owners to be given primary responsibility for maintenance; on a perpetual basis (unless a storm water utility is eventually formed). However, the County (in a "backup" role) needs to be able to step in and perform the maintenance if property owner fails, and needs to have security to provide funding for such backup maintenance. Security for "backup" maintenance after the interim period (5 years) would not be provided, however primary owner maintenance responsibility would remain. If a storm water utility or other permanent mechanism is put into place, it could assume either a primary or backup maintenance role.

Typical BMPs:
- Biofilters;
- Small Detention Basins;
- Infiltration BMP, and;
- Single Storm Drain Inserts, Oil/Water separator, Catch basin insert & screens.

For TM 5406 Second Category BMPs are: Clearwater BMP filtration devices & wet ponds as shown on the BMP map that is a part of this SWMP.

Primary responsibility for maintenance of the Clearwater filtration BMP's shall be given to the homeowners and/or HOA. Annual operation and maintenance costs for the Clearwater BMP's are $400 per the manufacturer's literature. Funding for maintenance will be paid for by the HOA. A security of $2,000 will be provided for the first five years.

Property owners, through the HOA, will have primary responsibility for maintenance of the wet ponds on a perpetual basis. Funds for maintenance will be collected from the HOA fee. Annual maintenance costs for the wet ponds will be $10,412.38. A security of $52,061.90 will be required for the first five years.

Funding:
Developer would provide the County with security to substantiate the maintenance agreement, which would remain in place for an interim period of 5 years. The amount of the security would equal the estimated cost of 2 years of maintenance activities. The security can be a Cash Deposit, Letter of Credit or other form acceptable to the County.

Mechanisms to Assure Maintenance:

1. Storm water Ordinance Requirement: The WPO requires this ongoing maintenance. In the event that the mechanisms below prove ineffective, or in addition to enforcing those mechanisms, civil action, criminal action or administrative citation could also be pursued for violations of the ordinance.

2. Public Nuisance Abatement: Under the WPO failure to maintain a BMP would constitute a public nuisance, which may be abated under the Uniform Public Nuisance Abatement Procedure. This provides an enforcement mechanism additional to the above, and would allow costs of maintenance to be billed to the owner, a lien placed on the property, and the tax collection process to be used.

3. Notice to Purchasers. Section 67.819(e) of the WPO requires developers to provide clear written notification to persons acquiring land upon which a BMP is located, or others assuming a BMP maintenance obligation, of the maintenance duty.

4. Conditions in Ongoing Land Use Permits: For those applications (listed in WPO Section 67.804) upon whose approval ongoing conditions may be imposed, a condition will be added which requires the owner of the land upon which the storm water facility is located to maintain that facility in accordance with the requirements specified in the SMP. Failure to perform maintenance may then be addressed as a violation of the permit, under the ordinance governing that permit process.

5. Subdivision Public Report: Tentative Map and Tentative Parcel Map approvals will be conditioned to require that, prior to approval of a Final or Parcel Map, the subdivider shall provide evidence to the Director of Public Works, that the subdivider has requested the California Department of Real Estate to include in the public report to be issued for the sales of lots within the subdivision, a notification regarding the maintenance requirement. (The requirement for this condition would not be applicable to subdivisions which are exempt from regulation under the Subdivided Lands Act, or for which no public report will be issued.)

6. BMP Maintenance Agreement with Easement and Covenant: An agreement will be entered into with the County, which will function three ways:
(a) It will commit the land to being used only for purposes of the BMP;
(b) It will include an agreement by the landowner, to maintain the facilities in accordance with the SMP (this obligation would be passed on to future purchasers or successors of the landowner, as a covenant); and
(c) It will include an easement giving the County the right to enter onto the land (and any necessary adjacent land needed for access) to maintain the BMPs.
This would be required of all applications listed in WPO Section 67.804. In the case of subdivisions, this easement and covenant would be recorded on or prior to the Final or Parcel Map.

ATTACHMENT I

Low Impact Design Techniques

The project uses the following LID techniques to reduce the impact of run-off:

1) Shared driveways.
2) Detention basin connected to roof downspout (down-slope from building).
3) Buildings aligned with topography to reduce grading.
4) Swale along parkway collects street run-off.
5) Roof drainage directed to landscape.